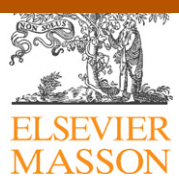

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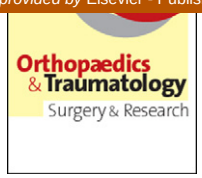

CLINICAL REPORT

Salmonella enterica subsp. *arizonae* bone and joints sepsis. A case report and literature review

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Accepted: 2 September 2008

KEYWORDS
Salmonella enterica subsp. *arizonae*;
Salmonella cholerasuis subsp. *arizonae*;
Septic arthritis of the hip;
Reptiles

Summary Osteoarticular infections caused by *Salmonella enterica* subsp. *arizonae* are rarely seen in humans but young children and immunocompromised adults are at particular risk of acquiring this bacteria. Reptiles and their by-products (e.g. meat preparations or medications) are particularly likely to harbor *Salmonella*. We report on a case of septic arthritis of the hip transmitted by a reptile in a 10-month-old child. We carry out a recall of the complex nomenclature of *Salmonella*, a review of the literature and provide information on the recommended precautions for reducing the risk of transmission of *Salmonella* from reptiles to humans.

Introduction

Salmonella enterica subsp. *arizonae* is an uncommon human pathogen. Most cases described in the literature occurred in the south-western United States, in immunocompromised infants and adults. These bacteria are usually transmitted to humans after direct or indirect contacts with reptiles or by ingestion of snake-based products (e.g. meat, traditional medicine preparations).

We report on a case of septic arthritis of the hip caused by *S. enterica* subsp. *arizonae* in a 10 month-old child contaminated by a pet snake. To the best of our knowledge, there is no similar case report in the French literature. The aim of the current study was to provide a clear interpretation of the complex nomenclature of *Salmonella*, to look through the literature and provide information on the recommended precautions for reducing the risk of transmission of *Salmonella* from reptiles to humans.

Clinical case

Antoine W., a 10 month-old boy with no previous medical history, was admitted to the emergency department with a history of painful left lower limb. The patient had developed an episode of high-grade fever (39.5 °C) 24 hours prior

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1877-0568/$ - see front matter © 2009 Published by Elsevier Masson SAS.
doi:10.1016/j.otsr.2008.09.010

to admission. Clinical examination suggested involvement of the hip joint and scan revealed a 3.8 mm articular effusion. Laboratory findings showed an inflammatory response (CRP: 68 mg/l, leucocytosis: 16.2×10^9/l). Clinical diagnosis of septic arthritis of the left hip was confirmed. Results of plain pelvic and left hip radiographs were normal. An articular puncture under general anesthesia was subsequently performed prior to traction of the limb and a probabilistic antimicrobial therapy of intravenously administered amikacine (15 mg/kg per day in one taking) and cloxacilline (100 mg/kg per day in three doses) was initiated. Bacteriological analysis of synovial fluid identified the presence of *S. enterica* subsp. *arizonae* and the isolate was subjected to antibiotic susceptibility testing. Blood cultures obtained at day 1, 2 and 3 were found to be sterile. A stool culture was performed 48 hours after the beginning of antibiotherapy and did not reveal the presence of the bacterium.

Since no clinical and biological improvement was observed at 72 hours, a scan was repeated. It provided evidence of a 7 mm articular effusion. Intra-articular puncture/drainage was performed again and adapted antibiotherapy was initiated according to antibiogram data (cloxacilline replaced by cefotaxime 100 mg/kg per day in three daily dosings). After 5 days of treatment, amikacine was stopped and cefotaxime administering was pursued. Clinical improvement and apyrexy were noted at 8 days with normalization of CRP level at day 14, a resin long leg pelvic cast was applied and intravenous ceftriaxone administration was continued for 4 weeks, 50 mg per day once-daily dosing regimen to facilitate home-care treatment.

Radiographic examination reported satisfactory outcome at 1 year follow-up with no recurrence of infection and no observable growth disorder.

Anamnesic data revealed that the family had acquired a corn snake 2 years ago which used to live in a vivarium up to then. The snake had escaped from its cage 2 weeks earlier and had been allowed to roam freely throughout the house. A stool culture from the snake yielded *Salmonella*.

Discussion

Salmonella nomenclature is complex and has been subjected to many changes and controversies. Nevertheless, good understanding of *Salmonella* nomenclature is necessary to carry out a relevant bibliographic research. *S. enterica* subsp. *arizonae* is a Gram negative bacillus and a member of the family *Enterobacteriaceae*, first described by Caldwell and Ryerson [1] in 1939 and named *Salmonella dar-es-salaam*. It was subsequently reclassified *Arizona hinshawii*, *Salmonella arizonae*, *Salmonella choleraesuis* subsp. *arizonae* and finally *S. enterica* subsp. *arizonae* in 2002 [2]. Currently, authors may choose among the two available systems of nomenclature: *S. choleraesuis* subsp. *arizonae* (old system) and *S. enterica* subsp. *arizonae* (new system) [3].

A review of the literature [4—17] from 1944 up to now reported 22 cases of osteoarticular infections caused by *S. enterica* subsp. *arizonae* (Table 1).

This series of 23 patients includes 10 males and 13 females. The average age was 30 years old (ranging from 7 months to 73 years). Two higher-risk groups can be established from this population: children under five with no particular medical history (six cases) and patients with severe underlying chronic pathology (19 cases), 11 of which are treated with long-term corticotherapy. Drepanocytosis is a well-known predisposing factor for osteoarticular infections caused by *Salmonella* [18].

The source of contamination was identified in 12 out of 23 patients; *Salmonella* infection was attributed to ingestion of snake-based traditional remedies in seven cases, exposure to a reptile in four cases and ingestion of non-pasteurized milk in one case.

Salmonella is usually contracted by consumption of contaminated eggs, snake meat and snake-based traditional medications [14,15] or hand-transmitted [19] as animal skin, feces and vivarium are particularly likely to be contaminated [20]. A case of transmission by animal bite is also reported [21]. In the present case, it was probably a hand-transmitted infection.

Specifically snakes, lizards, turtles and other cold-blood reptiles can act as reservoirs of *Salmonella* [17,20,22], 90% of reptiles are carriers of one or more species of *Salmonella*, potentially pathogenic for human. No serotype is specific to reptiles. Snakes are usually unaffected carriers but *S. enterica* subsp. *arizonae* might sometimes reveal pathogenic for animal [23].

The use of snake-based traditional medication preparations in Spanish—American communities in the southern United States accounts for the geographic repartition of osteoarticular infections caused by *S. enterica* subsp. *arizonae*. Our case report is the second one in Europe and the first one in France.

Annually, 93,000 reptile-associated cases of *Salmonella* infection (7%) are reported in the United States. Accurate diagnosis is challenging since clinical symptoms are frequently benign and do not lead to bacteriological investigations. There is an increasing prevalence of reptile-related *Salmonella* infections in the United States [25] due to the ever-growing number of pet reptile owners. From 1991 to 2001, the estimated number of households with reptiles doubled to reach 1.7 million or approximately 3% of the American households which represents 7.3 million reptiles [24,25].

Salmonella bacteria generally induce benign gastroenteritis but may also be an etiologic agent of severe infections (septicaemia, urinary tract infections, osteomyelitis, pericarditis, myocarditis, peritonitis). Diseases of the locomotive organs are uncommon.

Among the 23 patients of the series, the localized infection involves a single site in the body whereas eight cases demonstrate disseminated infections in various organs [2—7]. The knee is the most commonly affected joint (13 times). Associated symptoms, not involving the locomotive organs, are reported in 10 patients. They include gastroenteritis in six cases, urinary tract infections in six cases, septicemia in six cases and one case of septic complications in false aortic aneurysm.

Treatment of osteoarticular infections caused by *S. enterica* subsp. *arizonae* is not consensual. Actually, antimicrobial therapy is comprehensive and various lengths of treatment are available (from one week to lifetime treatments). Recovery was achieved in 19 patients (including our case), four patients died within 6 months (two of

Table 1 Presentation of the series.

Reference	Age	Gender	Associated pathology	IS	Type of osteoarticular infection	Other symptoms	Antibiotic course	Other treatments	Recurrence (treatment)	Outcome (last follow-up)
Fischer [4]	2 years old	M	Histiocytose X	NC	Disseminated osteomyelitis	Septicaemia, gastroenteritis	7 months	Radiotherapy	No	Recovery (1 year)
Krag and Shean [5]	63 years old	F	Idiopatic thrombopenic purpura	NC	Knee osteoarthritis	No	NC	Bone curettage	NC	Death
Guckian et al. [6]	52 years old	F	Disseminated lupus erythematosus, diabetes, Raynaud syndrom	Yes	Bilateral knee arthritis + pre tibial abscess	Urinary tract infection, gastroenteritis	(1) *Barre de visée proximale*	Articular drainage	Yes, 3 months antibiotherapy	Recovery
Hruby et al. [7]	2,5 years old	F	Drepanocytosis	NC	Disseminated osteomyelitis	Septicaemia	6 weeks		No	Recovery (8 months)
Smilack and Goldberg [8]	23 years old	F	Disseminated lupus erythematosus, drepanocytosis	Yes	Knee and shoulder arthritis + tibial abscess	No	NC		Yes	Recovery
Keren et al. [9]	53 years old	M	Ethylism	No	T12L1 vertebral osteitis	Gastroenteritis	3 weeks		Yes, 1 year antibiotherapy	Recovery (2 years)
Ogden [10]	1 year old	M	Drepanocytosis	No	Osteomyelitis	No	NC		No	Recovery
Ogden and Light [10]	2 years old	M	Drepanocytosis	No	Osteomyelitis	No	NC		No	Recovery
McIntyre et al. [11]	73 years old	M	Diabetes type 2, arterial hypertension	No	Right ankle arthritis	Septic aortic aneyrism, urinary tract infection	For life	Articular drainage amputation of the leg	No	Recovery (9 months)
Quismorio et al. [12]	31 years old	F	Disseminated lupus erythematosus, pulmonary tuberculosis	Yes	Left knee osteoarthritis	No	6 weeks		No	Death at 4 months for other reason
Quismorio et al. [12]	41 years old	M	Kidney transplant, chronic hepatitis B	Yes	Right knee arthritis	Kidney abscess	4 weeks		Yes, 1 week antibiotherapy	Death at 6 months for other reason

Table 1 (*Continued*)

Reference	Age	Gender	Associated pathology	IS	Type of osteoarticular infection	Other symptoms	Antibiotic course	Other treatments	Recurrence (treatment)	Outcome (last follow-up)
Quismorio et al. [12]	48 years old	F	Waldenström macroglobulinemy	No	Left knee osteoarthritis	Urinary tract infection, septicaemia, gastroenteritis	4 weeks	Reiterative puntures	Yes	Death due to recurrence
Croop et al. [13]	11 years old	M	NC	NC	Osteomyelitis	No	NC		No	Recovery
Cone et al. [14]	71 years old	F	Rhumatoïd polyarthritis	Yes	Iliac abscess + sacro iliac arthritis	Septicaemia, gastroenteritis	NC		No	Recovery
Kraus et al. [15]	27 years old	M	Dermatomyositis	Yes	Hip arthritis on THA	No	NC	Iterative drainages	No	Recovery (10 months)
Kraus et al. [15]	34 years old	F	Disseminated lupus erythematosus	Yes	Knee osteoarthritis	No	NC	Articular drainage	No	Recovery (19 months)
Kraus et al. [15]	14 years old	F	Disseminated lupus erythematosus	Yes	Bilateral knee osteoarthritis	Septicaemia	NC		No	Recovery
Kraus et al. [15]	36 years old	F	Disseminated lupus erythematosus	Yes	Knee and shoulder osteoarthritis	No	6 weeks	Articular drainage	No	Recovery (1 year)
Kraus et al. [15]	29 years old	F	Disseminated lupus erythematosus	Yes	Shoulder and bilateral knee osteoarthritis	Septicaemia, urine	4 weeks		No	Recovery
Kraus et al. [15]	61 years old	F	Primary biliary cirrhosis	NC	T10T11 vertebral osteitis	Urinary tract infection	NC		No	Recovery
Nowinski and Albert [16]	7 months	F	No	No	Proximal humeral osteoarthritis	No	10 weeks		No	Recovery
Foster and Kerr [17]	14 years old	M	No	No	Ankle arthritis	Gastroenteritis	NC		NC	NC
Our case report	10 months	M	No	No	Hip osteoarthritis	No	8 weeks	Articular drainage	No	Recovery (1 year)

NC: non communicated; IS: pathology or immunosupressive treatment.

Table 2 Centers of Disease Control and Prevention (CDC) recommendations for preventing transmission of *Salmonella* from reptiles to humans.

Recommendations for preventing transmission of *Salmonella* from reptiles to humans
Pet-store owners, health-care providers and veterinarians should provide information to owners and potential purchasers of reptiles about the risks of reptile-associated salmonellosis
Persons should always wash their hands thoroughly with soap and water after handling reptiles or their cages
Persons at increased risk for infection or serious complications from salmonellosis (e.g. children aged under 5 years or immunocompromised persons) should avoid contact with reptiles and any items that have been in contact with reptiles
Reptiles should be kept out of households that include children aged under 5 years or immunocompromised persons. A family expecting a child should remove the reptile from the home before the infant arrives
Reptiles should not be allowed in child-care centers
Reptiles should not be allowed to roam freely throughout a home or living area
Pet reptiles should be kept out of kitchens and other food-preparation areas to prevent contamination. Kitchen sinks should not be used to bath reptiles or to wash their dishes, cages or aquariums. If bathtubs are used for these purposes, they should be cleaned thoroughly and disinfected with bleach

which as a result of infection) and one patient underwent limb amputation due to the progression of infection. Five recurrences of infection were observed in patients with short course of antibiotherapy (1 to 4 weeks). The fluoroquinolones have potent activity against *Salmonella* and report good penetration into bone. However, these drugs are not recommended for use in children and in other specific cases. The use of a third-generation cephalosporin during a 6-week treatment is conceivable. It thus reduces potential antimicrobial-resistance in *Salmonella* bacteria.

Full respect for Centers of Disease Control and Prevention (CDC) recommendations for preventing transmission of *Salmonella* from reptiles to humans is the primary means of prevention (Table 2). There is no healthy carrier of *Salmonella* infection in humans.

What are the secondary precautionary measures? What do happen with *Salmonella*-positive animals? Treating animals with antibiotics may result in the evolution of drug-resistant organisms and reveals ineffective in rooting out *Salmonella* from the animal [24]. Considering the rarity of severe infections, banning pet reptiles is not justified. Therefore, getting rid of animals which are carriers of *Salmonella* is not approved and anyone should apply the CDC precautionary measures as the only accepted prevention.

Conclusion

The clinical diagnosis of *Salmonella* infection should be suggested on the basis of infection symptoms in patients who had contact with reptiles or having ingested reptile by-products.

In case of suspected *S. enterica* subsp. *arizonae* infection, contact with a reptile, ingestion of animal by-products, weakened immune system should be investigated.

A 6-week antibiotherapy made of third-generation cephalosporins or fluoroquinolones is highly advisable in persons at increased risk for *Salmonella* contamination and recurrent infections.

CDC recommendations for preventing *Salmonella* transmission should be taken seriously by all pet store personnel and reptile owners. CDC reports and recommendations are available on www.cdc.gov/mmwr/preview/mmwrhtml/mm5249a3.htm.

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